CERTAIN ASPECTS OF OCEAN DEPTHS STUDIES

by

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During the last decade the "Wityaz" survey vessel has been conducting extensive research in northwest Pacific. Working under the IGY program the "Wityaz" has covered certain parts of the Pacific, South off the Equator. At present the "Wityaz" is making its 28th cruise of which the latter three were devoted to the IGY program. Thus far the "Wityaz" has been sailing for about 13 months during the IGY.

On board the "Wityaz" there are 65-68 research workers including physicists, meteorologists, chemists, beiologists and geologists. The research done by the "Wityaz" is of an integrated nature with a view to the establishment of relations and inter-dependence of the chemical, physical and biological phenomena in their historical development and their relation to the structure and the development of the earth's crust, the study of all aspects of such a natural entity as the ocean, the halosphere.

Particular attention in this research was devoted to the investigation of deep water. During the past ten years the "Wityaz" has covered 220.000 miles of which 200.000 miles have been covered by echo sounding measurements, more than 1.000 deep water stations were made of which more than 100 have studied depths below 6000 m. i.e. ultra-abyssal depths. The instruments of the "Wityaz" have reached the greatest depths discovered by the expedition in the Marian trench which fall short of 11 km. only by 10 metres. This extensive work has resulted in the accumulation of many important findings.

The study of the marine bottom, essentially speaking, is a new and most promising department of geology which should help us to find answers to series of major geophysical problems.

The marine geologists must concentrate on the study of the distribution and thickness of bottom sediments in the ocean.

Unfortunately, this has not been enjoying the attention due it, while the obtained data are insufficient and contradictive. The formation of bottom sediments of the world ocean is a magnificent process of horizontal shift of the hard elements of the earth's crust entailing a volume of the order of more than a billion cubic kilometres. This mass exceeds greatly that of all mountains and is many times greater than the entire mass of glaciation during the glacier period. A question arises whether there can take place the bending of the earth's crust in the ocean bed under the impact of this tremendous mass of bottom sediments? On the other hand we face the question whether the accumulation of bottom sediments with thickness ranging for many kilometres should not result in the rising of the ocean bottom level. There should be either the bending of the bed or an rise in the level. But maybe, both processes were occurring simultaneously. However, in this case it must be borne in mind that bottom sediments cannot maintain permanently their initial volume. They become more compact and lose part of their moisture. On the margins of the oceans, in a space interpretation this should result in a reduction of tens of kilometres. It is also probable that the geophysical method of modelling is quite applicable in this case.

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The compilation of charts of bottom sediments must supply the answers to the theories of ocean and continent stability, and to the theory of mobility as well as to the question about the submerged continents.

From this point of view the methods of seismic determination of the thickness of bottom sediments require further elaboration and large scale employment considering the number of difficulties, such as the metamorphisation of the sediments, the lava streams, etc.

In all such studies one should always take into consideration that the masses of oceanic waters were unable to change their volume materially and, therefore, this one billion four hundred million cubic kilometres should have been always present

somewhere and the deep water bottom sediments were accumulating and were forming huge layers many kilometres thick on an area of 200.000.000 square kilometres.

Of similar necessity is the elaboration of core sampling methods not only by core samplers but by **dndependent** drilling instruments that could be lowered from a vessel and take huge pieces of the bottom extending not only for scores, but for hundreds of metres. Among other things this could supply the answers regarding the variation in ocean salinity during the preceding geological periods.

It is self-understood that there should be large scale employment of paleo-isotopic methods of analysis and not only the methods of paleo temperature and paleomagnetic analyses. The ground solutions of bottom sediments, in addition to other methods of ocean history study seem to be promising. The research carried out by S.Bruevitch and B.Kullenberg into paleosalinity of the Black and Baltic Seas should be practiced in the open areas of the oceans.

It is only natural that the troughs trenches particular attention. Until recently 17 were known for the Pacific of the 22 of the world ocean and last year the "Wityaz" had discovered the 18th trenches with a comparatively small depth, somewhat exceeding the level of the ocean bed.

The greatest depths of these trenches (according to G.Udintsev) are

Marian	10990 m	(10863)
Tonga	10840	(10633)
Kuril-Kamchatka	10382	
Philippine	10265	(10497?)
Kermadek	10030	(9611)
Idzu-Bonin	9764	(9611)
Bougenville	9140	(9040)
Yap	8597	
New Britain	8293	
Japanese	8412	northern part
Palau	8138	

Aleutan	7679
Atakam	7634
New Hebride	7570
Riu-Kiu	7507
Band	7260
Guatemala	6662
Wityaz	6140

It is clear that the trenches present one of the most interesting elements of the botton relief and attract great attention of the geologists. What are they?

Ordinarily they are regarded as modern (young) geosynclinal formations corresponding, according to G.Udintsev, to the "external margin of the regions with a continental type of the earth's crust structure".

P.Bezrukov quite correctly notes that the nature of the relief of deep water trenches, their high seismicity, the fact that they are close to the belt of modern vulcanic activity help to regard them as modern geoynclines in a state of bending and closely associated with depth fractures.

One can hardly doubt the geotectonic origin of the trenches.Udintsev also believes that "the morphological complex of the island ranges and depressions, and their geosynclinal geological complex correspond to the transitional state of the earth's crust and accompany its transformation from the oceanic into the continental state." It remains to be found out what is the relation in the formation of deep trenches between the structure of mother rock and that of the bottom sediments. Certain aspects attract attention which thus far have not been explained: very similar depths of the most deep water trenches — 10300-10990. This is certainly associated with some structural peculiarities of the bottom sediments and of the underlying mother rocks, if not the former alone.

As is indicated by P.Bezrukov, most often, we find on the steep slopes of the trenches dense clays and argillites, very compact and dehydrated. Apparently these are the stripped compact bottom sediments.

As to the 8th of the most shallow trenches in the Pacific, it is quite probable that their entire foundation lies in the mass of the bottom sediments. The other 4 trenches occupy an intermediate position (8400-10000 m). And the second is the mysterious flat surface of the trench's floor covered by clay ooze ranging at times from 1 to 5 kilometres and even more. What are the reasons for the bottom of the trenches to be so flat? It is most difficult to give the answer to all these questions before a thorough seismic-acoustic study of the trench bottom and of its slopes is made.

There is another very peculiar aspect in the relief of the Pacific ocean's bottom, namely, the meridianal bottom mountain ridge. Its split northern end comes up to the Aleut island range and stretches far southward across the Hawaian elevation. It divides the Pacific Ocean, similarly to that of the Atlantic, into the western and the eastern pa . Naturally, this is the longest mountain formation on the surface of the earth's crust. Its, nature, the geotectonic and geophysical significance are far from being known, while their interpretations are contradictive.

The distribution of the deep water fauna can help a lot in explaining a number of problems of marine geology and geophysics. It offeres strong arguments in our appreciation of the depth of the trenches.The ultraabyssal fauna of different trenchesis characteristic of a certain endemism, however, of a very young one. At times we find one and the same general habitating different trenches and ordinarily we find various subspecies and species.

Judging by the fauna we might conclude that these trenches are young formations aging not more than 3-4 million years, and not only is it young but a short-lived one, too. However, it might happen that under the bottom sediments of the Pacific there are many destroyed ancient trenches of varying age and it is hard to say whether the modern shallow trenches (7000-8000 m) are in their young or old age. The decisive word here will rest with seismography and gravimetry.

Physical oceanography is almost 100 years old. One of the great merits of this science is the elaboration of the general pattern of the water mass circulation in the ocean. However, this pattern, particularly as regard the deep waters is practically deprived of a very important element. We cannot say with the necessary accuracy as to what is the rate of the horizontal and vertical circulation of the entire mass of ocean waters with the exception of the most surface layer, what is the age of the water masses in the depths of the ocean: is it scores of years old or hundreds of years, or maybe even thousands of years?

Thus far, we have no reliable data to determine the age of the ocean as a whole, the age of its separate parts or of its deep tranches, we cannot determine the age of the bottom sediments or the age of the oceanic water masses, the rate of their movement-- in a word we are lacking reliable date for all this extensive and intricate chronology. Our science is merely trying to find these major indicators without which it is impossible to settle the basic problem regarding the history of the world ocean, its preformations, the history of its long and complicated life. By the way it should be admitted that there is very little that we know about the rate of evolution of the organic population of the ocean. In this case, too, we need quantitative indicators which are thus far absent. However, some very important considerations may be offered in favour of the argument that the evolution of the living organisms of the ocean cannot be restricted neither to two or to four billion years.

The pace of oceanic bottom water circulation determines many important indicators of the exchange between the halosphere and the atmosphere including the CO_2, thermal, humidity and other exchange.

The absence of an answer as to the age of the ocean bottom waters has become particularly felt during the last years when oceanologists were faced with the proposal about burying the radioactive industrial waste in the depths of the ocean. For

these purposes the Tong trench was even chosen. In 1957 the "Wityaz" had studied this question while operating in the area of that trench. V.Bogorov and E. Kreps arrived at the following conclusion .. "The analysis of the bottom relief of the trench, of the hydrological and hydrochemical regimen, the nature of bottom sediments, the presence of life at the greatest depths and the circulation of water is conductive to one conclusion only, namely, that the mixing of the water in the deep trenches is a sufficiently rapid process, that the radioactive compounds of waste materials buried in the deep water trenches and turning into solutions would unavoidably be carried to surface layers of the ocean within the range of economic activity of man, where sooner or later they will come into the organism of plants and animals, fish and mammals." It is true that no direct determination of the age regarding the depths waters of the Tong trench by the isotopic analysis method had been made, but the quoted conclusion leaves no place for doubts.

The distribution of life in the ocean both in its present state and in its geological past is most closely related to the formation of bottom sediments, to the circulation of world ocean waters in their historical development and with a number of most important geophysical problems.

The quantitative study of the distribution of life in the ocean has shown that its density in different parts of the ocean decreases by scores and hundreds of thousands of times as we depart from the coast and from the surface to the bottom. The least density of life has been discovered by the "Wityaz" in the Tong trench. It was determined to be of 1mg/m^2 of the surface of the bottom, while in the Kuril-Kamchatka trench it was 300-900 mg/m^2. This distribution is most closely associated with the entire sum total of environmental factors and in its turn is a subtle indicator of these factors. The changes in the distribution of life in the ocean are governed by the general geographical zonality which was most strikingly shown by V.Bogorov, by the findings of the 26th cruise of the

"Witjaz" in 1957. The population of the water and of the bottom is most scarce in the middle parts of the Pacific on a very vast area. The amount of plankton at a depth of 4-5 km. drops to fractions of a miligram in 1 m^3, while at the coast it is at times as much as several grams. As to the density of bottom population it drops from several kilograms to several miligrams in the middle part of the ocean. This negligible mass of life covers not less than four-fifths of the oceanic bottom. Moreover, the bottom sediments of this huge area are characteristic of very precise peculiarities which we do not find anywhere in the bottom rock brought to the surface of the earth. This is an indication that extreme care should be displayed towards attempts to deny the oceans of a geologically long and continuous existence.

I have no opportunity to speak in greater detail on the numerous problems of oceanology which have direct bearing upon geophysical sciences or even upon those which should have been among them and require elaboration.

In conclusion I wish to enumerate those departments of oceanology which require singular attention.

1. The thickness and the distribution of bottom oceanic sediments and their structure.

2. The nature and the rate of circulation of the bottom (200 m) waters of the ocean. The age of the oceanic depth waters.

3. The quantitative distribution of life in the ocean.

4. The elaboration of oceanic paleochronology.

5. The elaboration and large-scale employment of the methods offered by the seismological analysis of bottom sediments, of paleo-isotopic methods and of the methods of deep underwater drilling of bottom sediments.